BSDMS Summary Report

73 Pomme De Terre River at CR 22 near Fairfield, MN

Site Location:

Site ID: 73

Site Name: Pomme De Terre River at CR 22 near Fairfield, MN

County: Swift

Nearest City: Fairfield

State: MN

Latitude: 452304

Longitude: 0955646

USGS Station ID:

Route Number: 22

Route Class: County

Service Level: Mainline

Route Direction: NA

Highway Mile Point:

Stream Name: Pomme De Ter

River Mile:

Contact:

David Mueller
U.S. Geological Survey
9818 Bluegrass Parkway
Louisville, KY 40299

Publication:

Mueller, D.S., and Hitchcock, H.A., 1998, Scour measurements at contracted highway crossings in Minnesota, 1997: ASCE, Water Resources Engineering '98, Memphis, TN, p. 210-215.

Site Description:

Swift county road 22 over the Pomme De Terre River is three-span structure supported by round concrete pile bents. The site is located in a rural / agricultural area. During the flooding in April 1997, the USGS visited this site four times. The cross sections show a progression of scour at the right abutment. During all three visits the floodplain flow was concentrated in the right floodplain. This concentration of flow in the right floodplain is likely due to the channel alignment upstream of the bridge. The field crew searched for but could not define a location of flow reattachment along the right embankment. Flow was towards the main channel along the entire length of the embankment. The flow separated from the right embankment, nearly perpendicular to the main channel flow, and joined the main flow just left of the rightmost pier. During the 4-5-97 visit the flow from the right floodplain was so strong that a standing wave formed upstream of the bridge where the floodplain and main channel flow began mixing. The area from the rightmost pier to the right abutment was primarily slack and reverse flow. A slump failure in the right upstream highway embankment was observed during the last visit on 4-9-97. In July 1997 it was observed that riprap was used to fill scour at the right wingwall.

Cross-section data were collected using a chart-recording echo sounder with the transducer mounted on a knee board. The charts were digitized and scaled. Velocities were measured using standard discharge measurement procedures and a Price AA cup meter.

Manning's n reported the stream data are for the upstream reach. A complete

distribution of Manning's is provide below:

Upstream	Left	Main	Right	Downstream	Left	Main	Right
High	0.12	0.035	0.13		0.09	0.035	0.09
Typical	0.10	0.030	0.12		0.08	0.030	0.08
Low	0.08		0.08		0.07		0.07

Elevation Reference

Datum: MSL

MSL (ft):

Description of Reference Elevation:

Water-surface elevations were measured from the bridge deck. The elevation of the bridge deck was determined from the bride plans. All measurements were made between the leftmost pier and the left abutment.

Date	Time	Upstream	Downstream
4-4-97		1040.13	1039.85
4-5-97	1430	1040.57	1040.27
4-9-97	1800	1041.2	
7-15-97	1410	1032.75	

A local right-hand coordinate system was established with the postive y-axis in the upstream direction and the x-axis parallel to the upstream face of the bridge. This resulted in x-coordinates increasing from right to left. Since step backwater models typically us left to right coordinates, stationing was added which increases from left to right. The stationing on the two sections 500-ft upstream was adjusted so that the main channel aligned with the main channel at the bridge.

Stream Data

Drainage Area (sq mi): 836

Slope in Vicinity(ft/ft): 0.0006

Flow Impact: Straight

Channel Evolution Premodified

Armoring: Unknown

Debris Frequency: Unknown

Debris Effect: Unknown

Stream Size: Small

Flow Habit: Perennial

Bed Material: Sand

Valley Setting: Low

Floodplain Width: Wide

Natural Levees: Unknown

Apparent Incision: None

Channel Boundary: Alluvial

Banks Tree Cover: Medium

Sinuosity: Meandering

Braiding: None

Anabranching: Locally

Bars: Irregular

Stream Width Variability: Random

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Roughness Data

Manning's n Values

	Left Overbank	Channel	Right Overbank
High:	0.12	0.035	0.13
Typical	0.1	0.03	0.12
Low:	0.08		0.08

Bed Material

Measurement Number	Yr	Mo	Dy	Sampler	D95 (mm)	D84 (mm)	D50 (mm)	D16 (mm)	SP	Shape	Cohesion
1				BM-54	0.46	0.4	0.15	0.03	2.65		Non-Cohesive

Bed Material Comments

Measurement No: 1

The samples were collected from the upstream bridge face and appeared consist of non-cohesive fine sandy/silt with the following grain size distribution:

Size (mm)	4	2	1	.5	.25	.125	.062	.016	.004	.002
% < than	100	99.8	99.3	97.8	76.2	42.7	27.0	10.4	8.0	7.0

The boring logs of the site have been included in the bridge plan profile. Generally the logs indicate sand with some loam layers with fine gravel in the subbottom.

Bridge Data

Structure No: 76518

Length(ft): 120.8

Width(ft): 39.3

Number of Spans: 3

Vertical Configuration: Sloping

Low Chord Elev (ft): 1041.21

Upper Chord Elev (ft): 1041.57

Overtopping Elev (ft): 1043

Skew (degrees): 15

Guide Banks: None

Waterway Classification: Main

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Year Built: 1992

Avg Daily Traffic: 222

Plans on File: Yes

Parallel Bridges No

Upstream/Downstream: N/A

Continuous Abutment: No

Distance Between Centerlines:

Distance Between Pier Faces:

Bridge Description:

The bridge is a relatively new bridge with wide shoulders and concrete guardrails. The bridge is angled about 15 degrees to the low flow channel. All cross sections collected during the flood were collected approximately parallel to the bridge deck.

Abutment Data

Left Station: 584

Right Station: 705

Left Skew (deg): 15

Right Skew (deg) 15

Left Abutment Length (ft): 64

Right Abutment Length (ft) 64

Left Abutment to Channel Bank (ft): 0

Right Abutment to Channel Bank (ft): 0

Left Abutment Protection:

Right Abutment Protection

Contracted Opening Type: III

Embankment Skew (deg): -15

Embankment Slope (ft/ft): 2

Abutment Slope (ft/ft) 2

Wingwalls: Yes

Wingwall Angle (deg): 90

Pier Data

Pier ID	Bridge Station(ft)	Alignment	Highway Station	PierType	# Of Piles	Pile Spacing(ft)
1	666	15		Group	5	9
2	624	15		Group	5	9

Pier ID	Pier Width(ft)	Pier Shape	Shape Factor	Length(ft)	Protection	Foundation
1	1.33	Round			Unknown	Unknown
2	1.33	Round			Unknown	Unknown

Pier ID	Top Elevation(ft)	Bottom Elevation(ft)	Foot or Pile Cap Width(ft)	Cap Shape	Pile Tip Elevation(ft)
1				Unknown	
2				Unknown	

Pier Description

Pier ID 1

Pier ID 2

The piers are pile bents consisting of 5, 16-inch diameter concrete piles spaced 9 ft apart in a single line. The upstream and downstream piles are battered at 2 on 12.

Pier Scour Data

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Abutment Scour

Measurement Number	Abutment	Date	Time	US/DS	Scour Depth (ft)	Accuracy	Sediment Transport
1	Right	4/4/97		Upstream	3.9	1	Live-bed
2	Right	4/5/97		Upstream	4.1	1	Live-bed
3	Right	4/9/97		Upstream	10	1.5	Live-bed
4	Left	4/4/97		Upstream	3	1	Live-bed
5	Left	4/5/97		Upstream	2.8	1	Live-bed
6	Left	4/9/97		Upstream	2	1	Live-bed

Measurement Number	Velocity at Abut(ft/s)	Depth at Abut(ft)	Discharge Blocked(cfs)	Avg Velocity Blocked(ft/s)	Avg Depth Blocked(ft)
1		13.9			
2	8.3	15.6			
3	3.3	21.1			
4		13			
5	5	14.3			
6	5.1	14			

Measurement Number	Embankment Length (ft)	Bed Material	D50 (mm)	Sigma	Debris Effect
1	516	Unknown			Unknown
2	532	Unknown			Unknown
3	546	Unknown			Unknown
4	143	Unknown			Unknown
5	154	Unknown			Unknown

6	165	Unknown	Unknown

Abutment Scour Comments

MeasurementNo 1

The reference surface used to determine the depth of abutment scour was the concurrent ambient bed. Therefore, the depth of abutment scour reported is additional local scour below the depth of contraction scour. Based on the cross sections from the bridge plans there appeared to be little contraction scour.

Elevation of reference surfaces used:
4-4-97 1030
4-5-97 1029
4-9-97 1029

The rightmost pier may have had some influence on the depth of scour at the right abutment. It is difficult to separate its effect from the abutment. The abutment had the major effect and all scour is credited to the abutment with no scour reported for the pier.

The velocity reported for “at the abutment” is the maximum velocity observed in the area of the scour hole. Note that the velocity dropped considerably at the right abutment as the scour hole depth increased causing an increase in the flow area. The velocity at the left abutment held steady as did the depth and shape of the scour hole.

MeasurementNo 2

MeasurementNo 3

MeasurementNo 4

MeasurementNo 5

MeasurementNo 6

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ContractionScour

Measurement Number	Contracted Date	Contracted Time	Uncontracted Date	Uncontracted Time	US/DS	Scour Depth(ft)
1	4/4/97					0
2	4/5/97					0
3	4/9/97					0

Measurement Number	Accuracy	Contracted Avg Vel(ft/s)	Contracted Discharge(cfs)	Contracted Depth(ft)	Contracted Width(ft)
1	1				
2	1	4.23	4570	10.1	107
3	1	3.79	5150	12.5	109

Measurement Number	Uncontracted Avg Vel(ft/s)	Uncontracted Discharge(cfs)	Uncontracted Depth(ft)	Uncontracted Width(ft)	Channel Contraction Ratio
1					
2					
3					

Measurement Number	Pier Contraction Ratio	Scour Location	Eccent-ricity	Sediment Transport	Bed Form	Debris Effects
1		Main Channel		Live-bed	Unknown	Unknown
2		Main Channel		Live-bed	Unknown	Unknown
3		Main Channel		Live-bed	Unknown	Unknown

Measurement Number	D95 (mm)	D84 (mm)	D50 (mm)	D16 (mm)	Sigma Bed Material	Bed Material
1						Non-cohesive
2						Non-cohesive
3						Non-cohesive

Contraction Scour Comments

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Measurement No. 1

No hydraulic measurements were made on this date. However, from the channel geometry measurements no contraction scour was observed.

Measurement No. 2

Contraction scour was computed as the difference in average bed elevation between uncontracted and contracted sections, adjusted for bed slope.

Based on the elevation of the main channel between the abutment scour holes there appears to be only 1 ft or less of contraction scour and therefore a value of zero contraction scour is reported. No measurements in the uncontracted sections could be made. However, comparisons of the center of the contracted section with the cross section on the bridge plans collected in 1991 showed not change in elevation except in the areas effected by local scour. Thus, a zero contraction scour was reported.

The average depth and velocity of the contracted section were computed from the discharge measurements. The average depth included the abutment scour holes.

Measurement No. 3

Contraction scour was computed as the difference in average bed elevation between uncontracted and contracted sections, adjusted for bed slope.

Based on the elevation of the main channel between the abutment scour holes there appears to be only 1 ft or less of contraction scour and therefore a value of zero contraction scour is reported. No measurements in the uncontracted sections could be made.

The average depth and velocity of the contracted section were computed from the discharge measurements. The average depth included the abutment scour holes.

Stage and Discharge Data

Peak Discharge					Flow		Peak Stage					Stage	Water	Return
year	mo	dy	hr	mi	(cfs)	Qacc	year	mo	dy	hr	mi	(ft)	Temp (C)	Period(yr)
							1997	4	9			1041.2		
					5150		1997	4	5			1040.6		
					4570		1997	4	4			1040.1		

Hydrograph

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Supporting Files

PDT22-brgpln-profile.jpg - profile plot from bridge plan, includes bed material information.

Planview.wmf - is a file showing the bridge with a sketch of the channel and the locations of the cross sections. Note the location of the cross sections from the bridge plans located 500 ft upstream and downstream are approximate.

PDT22-pier-details.jpg - scan of bridge plan pier details
PDT22-topo.jpg
PDT22-brgpln-profile.jpg

Photos taken on 7-15-97:

PDT22-ds-bridge.jpg - photo along downstream edge of bridge

PDT22-ds-channel.jpg - photo of main channel downstream

PDT22-ds-lbnk.jpg - photo of left bank downstream from bridge

PDT22-ds-rbnk.jpg - photo of right bank downstream from bridge

PDT22-us-bridge.jpg - photo along upstream edge of bridge

CR22PDT.doc - MS Word summary of site, bridge and scour data
CR22PDT.xls - contains the following worksheets

cross sections are label by location upstream (us) or downstream (ds)
distance from bridge
date or source (bp is bridge plans)

See appropriate worksheet
us500_bp
us70_7-15
us50_7-15
us50_7-15(2)
usfv_bp
us0_4-4
us0_4-5
us0_4-9
us0Q_4-5
us0Q_4-9
us0Q_7-15
lsrtww_4-9 - longitudinal section along the right wing wall
lsp1p2_7-15 - longitudinal section between piers 1 and 2
ds0_4-4
ds0_4-5
ds0_7-15
dsfv_bp
ds10_4-9
ds15_4-5
ds20_4-9
ds25_4-4
ds40_4-5
ds50_4-4
ds50_4-9
ds50_7-15
ds80_4-5
ds80_4-5(2)
ds90_4-9

ds100_4-4
ds100_7-15
ds500_bp
Q4-5-97- velocities from discharge measurement on 4-5-97
Q4-9-97 - velocities from discharge measurement on 4-9-97
Q7-15-97 - velocities from discharge measurement on 7-15-97
Hydrograph - hydrograph from nearest gage